VOLTAGE BOOST CIRCUIT FOR A STYLUS PEN

BACKGROUND

[0001] A stylus or a stylus pen is often used as an input device to a digitizer associated with a computer screen, mobile device, graphics tablet, and other devices. With touchscreen devices, a user places a stylus on the surface of the screen to write, draw, or make selections by tapping the stylus on the screen. As such, the stylus is used as a pointing device in addition to a mouse, trackpad, or finger.

[0002] There is limited space for circuitry in a stylus, and any functionality should be built with minimal components. Due to the limited room, the stylus is typically powered by a single battery, such as an AAA or AAAA battery, which produce voltage levels of about 1.5V. Communicating with the digitizer is more effective if greater voltage levels can be used for the transmission. Transmissions at higher voltage levels result in a higher, and thus improved, signal-to-noise ratio ("SNR"). However, generating high voltage with a low-voltage battery while maintaining long battery life is challenging due to the restrictions on circuit size, cost, or power.

SUMMARY

[0003] This Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This Summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used to limit the scope of the claimed subject matter.

[0004] A stylus pen or other input device is disclosed that can be used as an input device to a digitizer associated with a computer screen on a computing device, such as a computer, mobile device, tablet, etc. The stylus pen can include a voltage boost circuit that generates a stylus output signal on an antenna for transmission to a digitizer.

[0005] The voltage boost circuit has a charging portion and a discharging portion. Both portions have transistors that are activated and deactivated through pulsed control signals. However, a pulse duration for each control signal is separately controllable through an RC-based circuit or a microcontroller or other timing control device. For example, a charging signal can have a pulse duration controlled through an RC timing circuit and the discharging signal can have a pulse duration controlled through an AC coupling circuit. Independent control of the pulse durations allows increased design freedom to meet desired circuit specifications including but not limited to the voltage amplitude of the boost.

[0006] Additionally, the voltage boost circuit provides power savings by draining the output voltage signal to a positive voltage rail, rather than ground.

[0007] The foregoing and other objects, features, and advantages of the invention will become more apparent from the following detailed description, which proceeds with reference to the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. **1** is a diagram illustrating a user writing on a computing device using a stylus pen according to one embodiment.

[0009] FIG. **2** is a circuit diagram of the stylus pen of FIG. **1** including a boost circuit according to one embodiment.

[0010] FIG. **3** is a circuit diagram showing a voltage boost circuit of FIG. **2** including control logic, a charge circuit and a discharge circuit.

[0011] FIG. **4** is a circuit diagram including details of the control logic of FIG. **3**.

[0012] FIG. **5** is a detailed circuit diagram of the charge circuit and discharge circuit of FIG. **3**.

[0013] FIG. **6** is an exemplary timing diagram for signals used in conjunction with the circuit of FIG. **5**.

[0014] FIG. **7** is a flowchart of a method for producing a stylus pen output signal.

[0015] FIG. **8** is a diagram of an example computing environment in which some described embodiments can be implemented.

DETAILED DESCRIPTION

[0016] A stylus pen is disclosed that includes a voltage boost circuit that can be used to communicate with a digitizer.

[0017] FIG. **1** is a diagram showing a stylus pen **100** in communication with a computing device **102** that includes a touch screen **110** to allow a user to write, erase, or move content displayed on the touch screen. The stylus pen **120** typically includes a first end **120**, called a stylus tip, for writing content and a second end **130** for performing a digital erasure of the content. The second end **130** can have additional functionality based on a degree of pressure applied thereto. In one example, the second end **130** can be clicked like a traditional pen in order to generate signals that are interpreted by the computing device **102** to perform a desired input function. As further described below, the stylus pen tip **120** and eraser end **130** transmit signals to the computing device **102** so as to operate as a user input device. Although a stylus pen is disclosed, the circuitry described herein can be inserted into other input device types (e.g., mouse, puck, etc.)

[0018] FIG. **2** is a schematic diagram illustrating example hardware that may be used with the stylus **100**. In this example, the stylus **100** includes hardware associated with a first portion **120** (the tip) and a second portion **130** (the tail end). As shown in FIG. **2**, the second portion **130** is different from and, in this example, complements the first portion **120**.

[0019] A control module **160** includes a plurality of components that are located in the first portion **120** and the second portion **130**. For example, the first portion **120** may include ASIC **200**, which includes the analog frontend circuitry to drive the stylus tip with different voltage waveforms. Thus, ASIC **200** may include amplifiers and other components to generate signals. The first portion **120** may include a clock generation source **205** (e.g., a 32.768 kHz crystal) associated with ASIC **200**. The second portion **130** may also include ASIC **210**, and a clock generation source **215** (e.g., a 100 kHz crystal) associated with the ASIC **210**. In this example, the ASIC **200** generates and/or adjusts a first signal (e.g., write signal, hover signal) and a sync signal.

[0020] The first portion **120** and/or second portion **130** may also include a radio **220**, a clock generation source **225** (e.g., a 16 MHz crystal) associated with the radio **220**, an RGB circuit **230**, and/or an inertial measurement unit ("IMU") **240**. In this example, the radio **220** enables the stylus **100** to exchange data with another computing device using, for example, a BLUETOOTH® brand wireless technology standard. (BLUETOOTH is a trademark of Blu-